

BULLETIN

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INSTITUTE NEWS

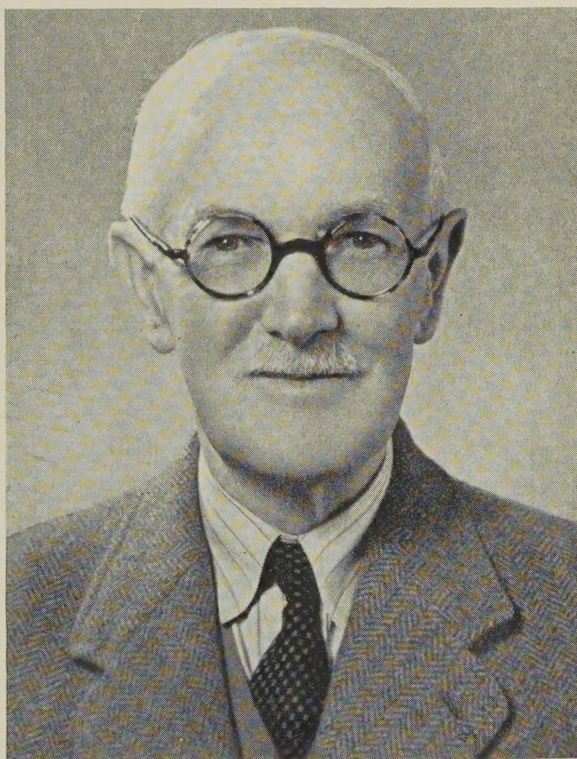
Election of Fellow

As briefly announced in the last issue of the *Bulletin*, Mr. G. SHAW SCOTT, M.Sc., F.C.I.S., Secretary Emeritus, has been elected a Fellow of the Institute.

Gilbert Shaw Scott was born at Walsall in 1884 and edu-

The title of Secretary Emeritus was conferred when he retired.

One of Mr. Shaw Scott's main hobbies has been motoring, and he was for more than 40 years Motoring Correspondent of the *Birmingham Post*. He continues to serve as a Member of the Executive Committee of the Automobile Association.



MR. G. SHAW SCOTT, M.Sc., F.C.I.S.

cated at Queen Mary's School, Walsall, and Birmingham University, where he was the first student to take the degree of B.Sc. in Metallurgy (1906). After engaging in research, for which he was awarded the M.Sc. degree, he was appointed Secretary of the Institute of Metals on its formation in 1908. This post he held until his retirement in 1944, by which time the Institute's membership had grown to about 2500. Until 1938 he was also Editor of the Institute's publications.

He is also a Member of Council of the Chartered Institute of Secretaries, and a Past-President of the Birmingham University Guild of Graduates (London Branch).

In recent years Mr. Shaw Scott has travelled extensively abroad, and during last winter toured a considerable part of Africa by car.

Mr. Shaw Scott married, in 1913, the elder daughter of the late Professor Thomas Turner.

Election of Council for 1956-57

In accordance with the Articles of Association, the following are due to retire from the Council at the 1956 Annual General Meeting: *President*: MAURICE COOK, D.Sc., Ph.D., F.I.M. *Past-President*: C. J. SMITHELLS, M.C., D.Sc., F.I.M. *Vice-Presidents*: Major C. J. P. BALL, D.S.O., M.C., F.R.Ac.S., and Professor G. V. RAYNOR, M.A., D.Sc., D.Phil., A.I.M. *Ordinary Members of Council*: Alfred BAER, B.A., N. I. BOND-WILLIAMS, B.Sc., A.I.M., N. P. INGLIS, Ph.D., M.Eng., M.I.Mech.E., F.I.M., IVOR JENKINS, D.Sc., F.I.M., A. G. RAMSAY, Ph.D., B.Sc., A.R.I.C., and H. SUTTON, D.Sc., C.B.E., F.R.Ac.S., F.I.M.

Under Article 19, Dr. MAURICE COOK, F.I.M., will fill the vacancy on the Council as Past-President.

In accordance with Article 22, the Council nominates the following members to fill the vacancies:

As President:

Major C. J. P. BALL, D.S.O., M.C., F.R.Ac.S., Chairman, Magnesium Elektron, Ltd., Manchester.

As Vice-Presidents:

N. P. INGLIS, Ph.D., M.Eng., M.I.Mech.E., F.I.M., Research Director, Imperial Chemical Industries, Ltd., Metals Division, Birmingham.

IVOR JENKINS, D.Sc., F.I.M., Chief Metallurgist, Research Laboratories of the General Electric Co., Ltd., Wembley, Middlesex.

As Ordinary Members of Council:

G. L. BAILEY, M.Sc., F.I.M., Director, The British Non-Ferrous Metals Research Association, London.

J. W. BERRY, M.I.Mech.E., Joint Managing Director, The Birmingham Aluminium Castings (1903) Co., Ltd., Birmingham.

G. E. DONO, J.P., Director, Sheet Metal Division, The Nuffield Organization, Oxford.

H. M. FINNISTON, B.Sc., Ph.D., A.R.T.C., F.I.M., Head of the Metallurgy Division, Atomic Energy Research Establishment, United Kingdom Atomic Energy Authority, Harwell, Berks.

Professor HUGH FORD, D.Sc., Ph.D., Wh.Sch., M.I.Mech.E., Professor of Applied Mechanics, Imperial College of Science and Technology, University of London.

C. H. M. HOLDEN, F.I.M., Managing Director, The Hall Street Metal Rolling Co., Ltd., Birmingham.

Members are reminded that, in accordance with Article 22, any ten members may also at, or before, the business part of the Autumn General Meeting (19-22 September 1955), nominate in writing, with the written consent to act if elected of the person nominated, any duly qualified person other than one of those nominated by the Council to fill any vacancy on the Council, but each such nominator is debarred from nominating any other person for the same election. If two or more persons are nominated for any honorary office they (or such of them as are not Ordinary Members of Council who are not retiring at the next Annual General Meeting) will be deemed to have been nominated also for any vacancies among the Ordinary Members of Council. No person is eligible to fill any vacancy at such Annual General Meeting unless he has consented in writing to be nominated and has been nominated or deemed to be nominated for the same in compliance with this Article.

Senior Vice-President, 1956-57

The Council has elected Dr. L. B. PFEIL, O.B.E., D.Sc., A.R.S.M., F.R.S., F.I.M., to serve as Senior Vice-President for 1956-57, and he will be their nominee for the Presidency in 1957-58.

Engineering, Marine, and Welding Exhibition

An official visit will be paid on Thursday, 8 September, by members of the Institute to the Engineering, Marine, and Welding Exhibition and the Foundry Trades' Exhibition, at Olympia, London, W.14. Tickets were distributed with the June issue of the *Journal*.

PERSONAL NOTES

MR. E. A. BOLTON has been elected a Member of Council of the Institution of Metallurgists.

DR. A. de S. BRASUNAS has left the University of Tennessee to join the Metals Engineering Institute, Cleveland, Ohio.

DR. H. T. CLARK has been appointed Director of Research of Jones and Laughlin Steel Corp., Pittsburgh, Pa. He was previously Manager of Metallurgical Research.

MR. D. EUROF DAVIES has been awarded a Travelling Fellowship by the Institution of Mining and Metallurgy to study non-ferrous smelting in Canada and the United States.

DR. W. A. DEAN, Chief Metallurgist at the Cleveland Works of the Aluminum Company of America, has been appointed co-ordinator of technological developments in titanium for the Company.

DR. L. W. DERRY, Head of the Department of Metallurgy at the Battersea Polytechnic, has received a Leverhulme Research Award to make a statistical investigation into the fatigue properties of certain non-ferrous metals.

DR. A. B. EVEREST has been elected President of the Institute of British Foundrymen for the year 1955-56.

DR. G. B. GREENOUGH has been appointed Senior Lecturer in Physical Metallurgy at Sheffield University.

DR. R. H. HICKLEY has left The Mond Nickel Co., Ltd., and taken a post in the Research Department of John M. Moorwood, Ltd., Sheffield.

DR. P. MELCHIOR has retired from his position as Manager and Vice-President of the Fachnormenausschuss Materialprüfung, Berlin.

MR. F. D. L. NOAKES has been appointed Metallurgist, Department of the Consulting Engineer, New Consolidated Gold Fields, Ltd., London.

MR. C. A. PARLANTI is now a Consulting Metallurgist at 320 Beacon Street, Boston 15, Mass.

DR. L. B. PFEIL has been awarded the E. J. Fox Medal of the Institute of British Foundrymen in recognition of his outstanding services to foundry industry and metallurgy and in particular for his work on high-temperature alloys.

MR. T. K. REDDON has left the Titanium Metals Corp. of America and is now with the General Electric Company, Cincinnati, Ohio.

MR. N. RIDLEY has been appointed Lecturer in Metallurgy at Sheffield College of Technology.

MR. H. S. SASTRI has been appointed Lecturer in Metallurgy at Rangoon University.

THE TREATMENT OF SWARFS, SAWINGS, AND RESIDUES **B12** IN THE NON-FERROUS METALS INDUSTRY

An Informal Discussion on "The Treatment of Swarfs, Sawings, and Residues in the Non-Ferrous Metals Industry" was held at Birmingham University on Wednesday, 16 February 1955, under the auspices of the Metallurgical Engineering Committee. Mr. W. J. Thomas, M.I.Mech.E., Chairman of the Committee, occupied the chair, and there was a good attendance.

Some of the salient points that arose during the discussion are summarized in the account below.

Introduction

EXCEPT for a few specialist papers, there is very little published information which covers adequately the wide range of processes in use for the recovery of metals or of metal salts from swarfs, residues, &c. Until about 20 years ago, the non-ferrous metals industry in Britain paid very little attention to this subject; for example, nearly all the available copper-bearing scrap and residues, amounting to 100,000 tons per annum, were sent to the Continent for treatment.

Just before and during World War II, the first attempts at large-scale treatment of scrap and residues were made in Britain. Today, considerable experience has been gained, and there is adequate capacity to meet the needs of the industry.

Having regard to the present state of growth in the non-ferrous metals industry, the necessity for metal economy, and the permitted increase in usage of secondary materials, metal recovery is of vital importance. This sphere of metallurgical activity is one in which technical and commercial considerations are very closely interlocked, and from the discussion it appeared that in nearly all recovery processes there are engineering problems at least comparable in magnitude with those of a chemical and metallurgical character, whilst the decision to apply a particular process depends much more on market considerations than is the case in normal melting and refining processes.

It emerged from the discussion that there can be no hard and fast rule regarding the type of material to be treated or how to treat it, and it must be left to the metallurgist-in-charge to decide in the light of market fluctuations what action should be taken.

The discussion provided opportunity for an exchange of views between all branches of the non-ferrous metals industry. In many instances, it was clear that processes applied in the light-alloy industry differed widely from those in the heavy non-ferrous metals industry, and the fact that one process is applicable technically and economically to light alloys is by no means an indication that it is equally desirable for the heavy non-ferrous metals.

Materials

The discussion covered two main residue groups: (i) residues of high free-metal content, such as sawing and machining swarfs, filings, foil scrap; and (ii) residues of low free-metal content, such as small metal particles intimately admixed or bound with non-metallic components, e.g. furnace slags, drosses, and skimmings. Such residues may be contaminated with moisture, volatile materials, oils, or organic materials.

It is the purpose of industrial residue treatment economically to recover a particular metal by providing a clean, compact

homogeneous mass, removing as far as possible at suitable stages mechanical impurities and undesirable alloying impurities.

Sampling

In order to judge which recovery treatment, if any, should be applied to a particular residue, reliable sampling for assay is the first essential. The sampling method depends upon the residue. For example, it is sufficient in the case of a residue in the form of small, loose, metal particles received from various sources, such as swarf and filings, to sample by quartering after blending; for long, curly turnings or large agglomerates of metal lumps with slag and flux, it is usually safer to determine the composition of the parcel by melting down a carefully selected portion and analysing both the ingot and the dross obtained.

Assaying

Ideally, the assay should cover exactly the size, shape, quantity, and composition of each component of the metallic residue, so that a rational treatment can be applied. In practice, it is not possible to achieve this ideal, but an experienced operator can base his assay on visual inspection of the sample. A laboratory-scale imitation of the separation method envisaged for production purposes is a valuable indication of the results which can be achieved. Moisture, volatile materials, oils, and organic materials are always determined by heating, sometimes in combination with degreasing.

Apart from the identification of free metal particles, it is important to identify metal oxides which may represent potential metal recovery. Aluminium and magnesium oxides cannot be recovered economically, so that determination of the total amount of aluminium in aluminium dross is misleading, knowledge of the proportion of free metal alone being of value. On the other hand, for copper-bearing residues an assay for copper oxides is of value since the reduction temperature for the oxides is of the same order as the melting temperature for copper. Furthermore, although the reduction of the oxides of low-melting-point metals such as lead, zinc, and tin is technically and economically sound, reduction is not effected at temperatures near the melting points of the metals, so that separate consideration has to be given to metal recovery from the oxides.

The chemist's report and assay certificate is the only basis on which the metallurgist-in-charge can decide how to effect economic metal recovery, and the treatment of the residue, on the basis of the assay, in general involves: (i) separation manually and/or mechanically of undesirable components, (ii) coalescence of the metal particles, and (iii) refining to remove undesirable alloying impurities.

Separation

The first stage of treatment, preparation for melting, is aimed at separating the mechanical mixture for proper utilization, and some of the operations adopted contribute at the same time, or even exclusively, to ease of handling and storage. Whether an impurity in the residue should be separated depends upon its usefulness in subsequent operations. Thus, for the converter refining of copper residues, free aluminium and iron need not be removed, since they represent fuel in the process. On the other hand, free iron must be removed from aluminium and brass residues, since it makes no useful contribution to the refining process and in alloyed form it is deleterious.

Hand-Sorting

Whether or not a consignment of scrap or residues can usefully be sorted depends on labour costs in relation to metal value and on the availability of suitable labour. Experienced sorters are not easy to find, but there are unskilled sorters who, although lacking special knowledge of metals, can sort according to shape, appearance, weight, and in other similar ways. Hand-sorting is a slow process, and experience has shown that if the metal recovery is less than 50%, mechanical or metallurgical methods are in most instances better paying propositions. Of equal importance, of course, is metal price. Hand-sorting may not pay for aluminium or brass, but will easily pay if applied to nickel and nickel alloys.

Drying

Under normal trade customs, a certain proportion of moisture and/or oil is allowed in fines, residues, swarfs, sawings, &c., and this has become generally accepted as an unalterable factor. The influence of such contamination on the economy of metal recovery was shown to be quite marked. If, for example, undried swarf or similar residues are charged into the melting furnace, the cost of moisture and oil removal during melting is much higher than that of previous drying. This applies particularly to melting in electric induction furnaces, where the power input is more or less fixed and the moisture is boiled out both before and during melting. This removal of moisture can easily take up to 2 or 3% of the total current consumed in melting, and is the equivalent of running the furnace for one full week per annum.

Hot-air dryers, of the kiln type or of other shapes and designs, and centrifuges are used for the removal of liquid contaminants from swarfs and other residues. Each method has its advantages and disadvantages. Kiln-type dryers remove moisture and oil cheaply and effectively, but the loss of fine metal particles with the escaping draught can be considerable, and this sometimes weighs heavily against the method. On the other hand, centrifuges, though rapid in operation, do not remove moisture and oil completely, and centrifuged material may still contain about 2% liquid contamination. Whilst kiln-drying apparently has been adopted successfully in the copper industry, at least one aluminium concern treats oily aluminium alloy swarf by initially centrifuging in superheated steam, followed by final kiln-drying to remove the last traces of moisture and oil; this procedure has been adopted as a result of outbreaks of fire and complaints about fumes when kiln-drying only was used. Centrifuging in steam was said to be effective in removing both solid and liquid lubricants. The use of detergents in the centrifuge was suggested as a means for reducing oil content, although, during the discussion, the view was expressed that steaming would be much more effective. Even if moisture and oil

are not expected to interfere with subsequent melting, they may affect certain mechanical operations such as magnetic separation. Excessive oil is a nuisance in furnace charging, because of the flames and fumes produced.

Solid organic materials, such as paper or plastic backing on aluminium foil, are undesirable because of the production of flames and fumes in melting and also because in some cases large residues of charcoal on the metal particles interfere with coalescence. Such organic contaminants are removed by charring in a separate operation, and the charred matter separated from the metal by screening or elutriation in air.

Milling and Screening

In order to facilitate the handling and further processing of tangled masses of intertwining brittle turnings, they are broken up in pan or mortar mills. Turnings in more ductile materials such as pure aluminium do not respond to this treatment and may be briquetted for melting or fed straight into the furnace. Mixtures from turnings coming from tough or ductile alloys and partly from brittle alloys may be at least partially separated by milling and screening, the tough alloy remaining on the screen while the brittle material passes through. Hot screening can be used to separate a mixture of high- and low-temperature metal particles such as copper and Babbitt metal, the screening temperature being slightly above the melting temperature for the latter.

Metal-containing drosses, skimmings, &c., are normally available in large agglomerates which are broken up in a large variety of mills and breakers, both dry and wet, and it is only after the material has been reduced to a certain fineness that treatment for metal recovery can begin. Many modern mills combine milling and screening. Where the dividing line between coarse and fine material is drawn depends upon the metal to be recovered and, further, on the type of melting furnace available. In some cases, suitable markets can be found for the fines, e.g. very fine material from aluminium dross is used as parting sand by some foundries, and other aluminium dross fines are used for making concrete and aluminous bricks. In general, the coarse particles retained by the screen, after magnetising if necessary, are returned to the furnaces. A combination of commercial and metallurgical considerations determines whether the fines should be further treated by such processes as elutriation or flotation or by chemical processes.

Magnetic Separation

Magnetic separation is used to extract particles of ferromagnetics such as iron, steel, cobalt, and nickel, and most works apply a double magnetising process to ensure the most efficient treatment of milled swarf, sawings, filings, screened particles, &c. It is important that such residues should be as free as possible from moisture, oil, and other lubricants, for otherwise surface-tension effects may prevent the effective removal of ferromagnetic particles. The introduction quite recently of a number of magnetising machines incorporating permanent magnets instead of conventional electromagnets appears to represent a real advance, since the risks associated with unnoticed current failures are obviated.

Briquetting

It was observed that the briquetting press takes a large part of liquid contamination out of swarf—in fact nearly all that remaining after normal centrifuging. Considerable discussion centred round the question of the desirability of briquetting swarf before melting. In general, it appeared that light-alloy

concerns found no advantage in briquetting, whereas a number of firms dealing with brass and copper swarf preferred briquetting to using loose swarf. Where rotary or reverberatory melting furnaces are used, the charging of loose swarf is of advantage whilst briquettes may be more suitable for induction-furnace melting.

Flotation

In connection with the possible advantages offered by flotation processes for separating finely divided mixtures of oxides and metal, &c., it was noted that specific flotation agents had been evolved for use in the ore-dressing industry. These have been available in the U.S.A. and Europe and adapted successfully to the recovery of fine copper powder. Plant has also been developed on the basis of the Sherritt process and is working successfully today, yielding nickel and cobalt powder direct from concentrates, with the possibility of adaptation later to copper residues. It was suggested that more attention should be given to flotation principles in metal recovery.

Chemical Processes

Chemical treatment on the whole must be considered more expensive than metallurgical processes, but the yields are usually much higher. Brief reference was made in the discussion to the possible application in the distant future of the catalytic distillation of even high-boiling-point materials such as aluminium from very finely divided mixtures, such as dross residues, which at present cannot be recovered metallurgically. Reference was also made to the halide process for the extraction of very high-purity aluminium from heavily contaminated secondary metal, and to plant which is now in successful operation in the U.S.A. for the separation of high-grade copper powder from copper-bearing scrap, on the basis of precipitation from a solution in ammoniacal ammonium carbonate.

Coalescing, Melting, and Refining

After treatment of swarf, drosses, and similar residues according to the various ways discussed, the metal particles are combined generally by furnace melting. Fluxes are used in melting as protection against oxidation, to dissolve residual oxides, or to envelop them and other non-metallic particles. Control of the furnace atmosphere by adjusting the fuel: air ratio is a further measure taken to minimize oxidation. Stirring or furnace rotation is an effective aid to coalescence in the case of light-metal particles which have tenacious oxide films. Very fine metal particles introduce particular problems for obvious reasons.

Reference was made to a recent development in treating very fine metallics which, under ordinary conditions of melting, oxidize rapidly and are lost. The fine metallics are mixed with a fluoride-containing flux binder into a cement form, cast into briquettes, dried, and charged into the furnace; metal recovery as high as 99% was in some cases being achieved by this method. It was suggested that pelletizing might be more economic than briquetting, and reference was made to a recent Finnish development, stated to be in successful operation, in which the pelletizing machine comprised a rotating disc inclined at 45°, material being fed in at the centre and the pellets removed from the rims. The British Iron and Steel Research Association were said to be using an inclined corrugated shaking board into which the metallic fines were fed at the top and the rolled pellets removed continuously at the bottom.

The various melting furnaces and ways of refining were

touched upon occasionally in the discussion, but only as much as was necessary to decide for or against a certain process of pre-treatment. On the whole, none of the metallurgical processes mentioned differed in any essential way from other well-known melting and refining processes.

LETTER TO THE EDITOR

Colour Coding of Alloys

The system for the colour coding of commercial alloys suggested by Kornfeld¹ seems to have much to recommend it. The sequence of colours used in coding should, however, be easily distinguishable, whereas in the system referred to there seems to be a possibility of confusion between blue, lilac, and violet.

The common system of colour coding used for resistors and condensers replaces lilac by grey, and as an aid to memory, the colour sequence includes the colours of the spectrum in order. It appears desirable that this sequence should become standard. The figures from 0 to 9 would then be represented successively by the colours: black, brown, red, orange, yellow, green, blue, purple, grey, and white.

J. GRAHAM

*Department of Physical Metallurgy,
University of Birmingham.*

REFERENCE

1. K. Kornfeld, *Bull. Inst. Metals*, 1955, **2**, 262.

APPOINTMENTS VACANT

A COMPANY 20 miles West of London requires an Assistant Chemist for the analysis of copper- and nickel-base alloys, stainless steel. Knowledge of spectrographic analysis an advantage. Salary according to age, qualifications, and experience. Applications to Box A.439, Willing's, 362 Gray's Inn Road, London, W.C.1.

A METALLURGIST is required for investigation of problems in the field of physical metallurgy, including a basic study of diffusion, or of certain aspects of recrystallization behaviour. It is anticipated that the results may be suitable for publication. The vacancy would suit a recent graduate (one or two years' industrial experience would be an advantage, but is not essential). A pension scheme is in operation. Applications should be addressed to the Director of Research, Aluminium Laboratories Limited, Banbury, Oxon.

A VACANCY exists for an X-Ray Crystallographer to work as a member of a new and expanding group engaged in investigating fundamental behaviour and properties of alloys. The work initially involves the application of special X-ray techniques to the study of precipitation phenomena. Some research experience is required, but need not necessarily be in the particular field outlined above. The work is interesting and progressive, and provides an unusual opportunity for a man with initiative and enthusiasm to perform original research, which may be suitable for publication. The laboratories are situated in pleasant country surroundings and have recently been extended. The salary will be attractive and in accordance with age and experience. A pension scheme is in operation. Applications should be addressed to the Director of Research, Aluminium Laboratories Limited, Banbury, Oxon.

IMPERIAL CHEMICAL INDUSTRIES, LIMITED, WILTON WORKS, MIDDLESBROUGH, requires a Metallurgist in the Engineering Materials Section. Preference will be given to candidates under 30 years of age with a 1st or 2nd Class Honours Degree in Metallurgy, but previous industrial experience is not essential. Work will include investigation of plant failures and associated problems in welding, corrosion, and protection of metals, and the post offers scope for wide general experience in this field. The laboratories are newly built and well equipped. Apply in writing to the Staff Manager, Imperial Chemical Industries, Ltd., Wilton Works, Middlesbrough, Yorks., or to the nearest Employment Exchange quoting advertisement ref. ICI/X/247/i.

APPOINTMENTS VACANT

IMPERIAL SMELTING CORPORATION, LIMITED, invites applications from Metallurgists, Chemists, or Chemical Engineers for openings in the Plant Investigation Departments at the Avonmouth and Widnes Works. Honours Degree is preferable, previous experience not essential, and applications will be welcomed from persons completing their National Service. Opening also available for Physical Metallurgist in Research Laboratory for investigational work on alloys. Applications giving full details to Personnel Manager, Imperial Smelting Corporation, Ltd., St. Andrew's Road, Avonmouth, Bristol, quoting reference GRA/IM.

JOSEPH LUCAS LIMITED, Burnley, require a research metallurgist or physicist (graduate) for work on the fundamental properties of materials for high-temperature applications. Some experience of vacuum and metallographic techniques desirable. Salary according to age and experience. Write, giving full details, to Personnel Department, Hargher Clough Works.

METALLURGICAL CHEMIST required in St. Luke's Printing Works now at Old Street, London, E.C.1., but moving early next year to Debden, near Loughton, Essex. Applicants should have some experience in electrodeposition processes and preferably also in a field of research. The post would carry responsibilities for the production of printing plates by existing processes, for technical developments, and for the replanning at the new factory which these developments would necessitate. Starting salary up to £1000 according to age and experience. The appointment would be permanent and pensionable under a non-contributory scheme. House purchase facilities. Candidates, who should be British by birth and under 35, are invited to write stating age, full details of education, training, and experience to the Staff Manager, St. Luke's Printing Works (Bank of England), Old Street, London, E.C.1.

METALLURGIST required for Aircraft Research Laboratories. Candidates should hold degree or equivalent, with some industrial experience in at least one of the following: physical testing, foundry technology, thermal treatments, and metallography. Good prospects and salary for suitable applicant. Please write to Box No. 393, The Institute of Metals, 4 Grosvenor Gardens, London, S.W.1, quoting reference M.245.

SOUTH AFRICAN BUREAU OF STANDARDS: VACANCY FOR METALLURGIST. Applications are invited from suitably qualified persons for appointment as Metallurgist. Applicants should hold at least a B.Sc. degree with Chemistry and/or Metallurgy as a major subject or an equivalent qualification. Experience in metallurgical analysis and a knowledge of the metallurgy of iron and steel will be a recommendation.

The salary scale is £1020 × 60—£1380 plus a cost of living allowance of £234 per annum in the case of married officers.

It is obligatory to become a member of the Provident Fund, which involves a contribution of seven per cent. of basic salary, and a similar contribution by the Council of the South African Bureau of Standards.

The successful applicant will be appointed on a contract basis for three years and will be paid full salary as from the date of embarkation, plus cost of rail and second-class boat fares for himself and immediate family. Should the successful applicant terminate his contract within a period of less than three years he will be required to refund a *pro rata* proportion of the expenses incurred in bringing him and his family to South Africa. After the expiry of the three years' contract period the successful applicant will be on the Bureau's staff subject to the normal conditions of employment. In addition, the successful applicant will after three months' service with the Bureau also be entitled to claim a refund of 50 per cent. or £60, whichever is the lesser (in the case of married officers), or 50 per cent. or £20, whichever is the lesser (in the case of single officers), of the cost of transporting his furniture and personal effects to Pretoria, such claim to be properly substantiated by receipts.

Applicants giving full details regarding age, marital status, nationality, knowledge of English, scientific and technical qualifications and experience, together with a medical certificate of health and the names of at least two persons to whom references may be made, should be sent to the Secretary, South African Bureau of Standards, Private Bag 191, Pretoria, South Africa, immediately.

THE ALUMINIUM DEVELOPMENT ASSOCIATION requires a Senior Metallurgist or Chemist to be responsible for general development work in new applications of aluminium, with particular reference to finishing and surface-treatment processes. The work is of a varied and interesting nature and with wide scope for develop-

ing new processes and techniques. Specialized knowledge of aluminium technology is not essential, but applicants should have a general knowledge of metallurgy and at least 3 years' industrial or research experience: a degree or equivalent qualification is essential. Salary according to qualifications and experience. Applications to be made to the Technical Director, The Aluminium Development Association, 33 Grosvenor Street, London, W.1.

THE BROKEN HILL PROPRIETARY CO., LTD., RESEARCH DIVISION: VACANCIES FOR RESEARCH WORKERS. Opportunities exist for honours graduates and those possessing research degrees in Metallurgy, Chemistry, Physics, and Engineering for work in the Central Research Laboratories now being established at Shortland, near Newcastle, Australia.

Attractive salaries are offered, commensurate with training and experience. Successful applicants will be eligible to join the Company's Officers Provident Fund and to participate in other benefits provided for the professional staff.

Further information concerning the plans for the Research Division may be obtained from the Director of Research Elect, Professor Howard K. Worner, who is at present Professor of Metallurgy and Dean of the Faculty of Engineering in the University of Melbourne, Carlton, N.3, Victoria.

Applications should be addressed in writing to the Managing Director, Broken Hill Proprietary Co., Ltd., Box 86A, Melbourne, Australia.

TWO VACANCIES exist in a team working on the Casting of Aluminium Alloys. A long-term programme of work is in progress covering a study of the semi-continuous casting process, in particular on problems involved in temperature distribution, thermal transfer, and the influence of these factors on metallurgical structure. Techniques for rapid temperature measurement, use of electrical analogies, and for the use of radioactive tracers may interest applicants. The vacancies would suit recent graduates, but a few years' industrial or research experience would be a distinct advantage. A pension scheme is in operation. Applications should be addressed to the Director of Research, Aluminium Laboratories Limited, Banbury, Oxon.

COLLEGE OF TECHNOLOGY, BIRMINGHAM DEPARTMENT OF METALLURGY

Applications are invited for the following posts:

1. Lecturer to specialize in the teaching of Physical Metallurgy.
2. Lecturer to specialize in the teaching of Industrial Metallurgy.

Candidates should have an Honours Degree in Metallurgy of a British University or equivalent together with teaching experience and also some experience of metallurgical research or industry. Responsibilities include teaching to Honours B.Sc. (Metallurgy) and A.I.M. standards together with participation in the Post-Graduate and Research Work of the Department, to be further developed in the new College, which is being equipped in 1955-56. Salary will be in accordance with the Burnham (Further Education) Scale for Lecturers (Men) £965 × £25—£1065.

Appointment to date from 1 September 1955, or as soon as possible after that date.

Further particulars and form of application may be obtained from the Registrar, College of Technology, Suffolk Street, Birmingham 1, and completed forms should be returned to him not later than two weeks after the appearance of this advertisement.

K. R. PILLING.
Clerk to the Governing Body.

X-RAY DIFFRACTION

The Nelson Research Laboratories invite applications from recent graduates or students graduating this year in

PHYSICS CHEMISTRY OR METALLURGY

who are free from National Service liability. This is an opportunity to be engaged in interesting research work in the fields of CERAMICS and METALLURGY. Please apply to Dept. C.P.S. 336/7, Strand, W.C.2, quoting Ref. 1212B.

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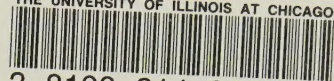
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